ZooKeys 1191: 379–389 (2024)
DOI: 10.3897/zookeys.1191.113811

Research Article

Review of *Anaka* Dworakowska & Viraktamath, 1975 (Hemiptera, Cicadellidae, Typhlocybinae) with the descriptions of five new species from China

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Abstract

The dikraneurine leafhopper genus *Anaka* is reviewed based on a comparative morphological study. Five new species, *Anaka auricula* **sp. nov.**, *Anaka cruciata* **sp. nov.**, *Anaka curvata* **sp. nov.**, *Anaka rosacea* **sp. nov.**, and *Anaka spiralis* **sp. nov.** from China are described and illustrated in detail. Additionally, a key to known *Anaka* species is provided along with a checklist of all species and their distributions.

Key words: Auchenorrhyncha, Dikraneurini, leafhopper, morphology, taxonomy

OPEN ACCESS

Academic editor: J. A. Pinedo-Escatel
Received: 7 October 2023
Accepted: 21 January 2024
Published: 16 February 2024

ZooBank: https://zoobank.org/9D8348E2-083A-4D1A-83C0-4DE969498A3A

Citation: Jiao M, Yang M, Yu X, Yan B (2024) Review of *Anaka* Dworakowska & Viraktamath, 1975 (Hemiptera, Cicadellidae, Typhlocybinae) with the descriptions of five new species from China. ZooKeys 1191: 379–389. https://doi.org/10.3897/zookeys.1191.113811

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Introduction

The typhlocybine leafhopper genus *Anaka* Dworakowska & Viraktamath, 1975 belonging to the tribe Dikraneurini was erected by Dworakowska and Viraktamath (1975) with *Anaka colorata* from India as the type species. Thapa and Sohi (1986) added *A. nepalica* and *A. spinosa* from Nepal. Dworakowska (1993) added *A. blada* (India), *A. sumatrana* (Indonesia), *A. shashidhari* (India), *A. burmensis* (Upper Burma), and *A. roryi* (China). Thus, eight species of the genus have been reported to date. Here, we review the previously known species and describe five new species, *Anaka auricula* sp. nov., *Anaka cruciata* sp. nov., *Anaka curvata* sp. nov., *Anaka rosacea* sp. nov. and *Anaka spiralis* sp. nov. from China. We also provide a key to males of all recognized species of the genus.

Material and methods

All specimens identified in this study were collected by net trapping in southern China and are housed at the Institute of Entomology, Guizhou University, Guiyang, Guizhou, P. R. China (**GUGC:10657**).

Dry specimens were used for preparing descriptions and illustrations. External morphology was observed under a stereoscopic microscope. Body length was measured with an ocular micrometer, in millimeters, from the apex of the

head to the apex of the forewing in repose. The genital segments of the specimens examined were macerated in 10% NaOH, washed in water and transferred to glycerin. Male specimens were dissected under a MOTIC B1 SMS-168 SERIES microscope. Figures were made using an OLYMPUS CX41 compound microscope. Photographs were taken with Keyence VHX-1000 and an Olympus E-520 digital camera. The digital images were then imported into Adobe Photoshop CS6 for labeling and figure composition.

Taxonomic account

Genus *Anaka* Dworakowska & Viraktamath, 1975

Anaka Dworakowska & Viraktamath, 1975: 521.

Type species. *Anaka colorata* Dworakowska & Viraktamath, 1975 (type locality: India).

Description. Vertex rounded, coronal suture distinct. Face rounded gradually to vertex, flat, lorum broad. Ocelli vestigial. Pronotum ~ 3× longer than head in dorsal view, as broad as head with eyes. Scutum with scutellum distinctly shorter than pronotum. Forewing broad, 3rd apical cell stalked. Hind wing veins RP and MA confluent in male. Hindwing narrow, membrane smoked, veins dark, area bordered.

Abdominal apodemes well developed, reaching caudal margin of 4th abdominal sternite. Pygofer side dark, well sclerotized, dorsal lobe the darkest, hind and ventral margins not pigmented, row of microsetae caudad. Subgenital plate has group of few big macrosetae at approximately mid-length, numerous thin short microsetae present at apical 1/3, several small rigid setae near macrosetae, and a row of thin long setae on basal 1/2 of ventral margin. Paramere hooked at apex, strongly attached to subgenital plate. Connective fused with aedeagus (Dworakowska and Viraktamath 1975). Aedeagus tubular, with basal or apical processes. Dorsoatrium well developed. Gonopore apical.

Distribution. China (Guizhou, Guangdong, Guangxi, Yunnan, Sichuan, Chongqing, Hunan, Zhejiang, Fujian, Taiwan), India, Nepal, Sumatra, Indonesia, Burma.

Checklist of *Anaka* Dworakowska & Viraktamath, 1975

1. *Anaka auricula* sp. nov.

Distribution. China (Guizhou).

2. *Anaka blada* Dworakowska, 1993

Anaka blada Dworakowska, 1993a: 161.

Distribution. India.

3. *Anaka burmensis* Dworakowska, 1993

Anaka burmensis Dworakowska, 1993a: 163.

Distribution. China (Guizhou, Sichuan, Yunnan, Chongqing, Guangdong, Fujian), India.

4. *Anaka colorata* Dworakowska & Viraktamath, 1975

Anaka colorata Dworakowska & Viraktamath, 1975a: 523.

Distribution. India.

5. *Anaka cruciata* sp. nov.

Distribution. China (Yunnan).

6. *Anaka curvata* sp. nov.

Distribution. China (Guangdong, Guangxi).

7. *Anaka nepalica* Thapa & Sohi, 1986

Anaka nepalica Thapa & Sohi, 1986a: 54.

Distribution. Nepal.

8. *Anaka roryi* Dworakowska, 1993

Anaka roryi Dworakowska, 1993c: 116.

Distribution. China (Taiwan).

9. *Anaka rosacea* sp. nov.

Distribution. China (Guizhou).

10. *Anaka shashidhari* Dworakowska, 1993

Anaka shashidhari Dworakowska, 1993a: 162.

Distribution. India.

11. *Anaka spinosa* Thapa & Sohi, 1986

Anaka spinosa Thapa & Sohi, 1986a: 56.

Distribution. India, Nepal.

12. *Anaka spiralis* sp. nov.

Distribution. China (Yunnan).

13. *Anaka sumatrana* Dworakowska, 1993

Anaka sumatrana Dworakowska, 1993a: 162.

Distribution. Sumatra.

Key to males of the genus *Anaka* Dworakowska & Viraktamath, 1975

1 Aedeagus with processes basally **2**
– Aedeagus with processes apically **8**
2 Aedeagal processes extended beyond apex of shaft **3**
– Aedeagal processes shorter than or equal to shaft **5**
3 Aedeagal processes sculptured **4**
– Aedeagal processes smooth ..... ***A. sumatrana***
4 Aedeagal processes with areolate sculpture distally and parallel grooves basally ..... ***A. roryi***
– Aedeagal processes with distal areolate sculpture only ..... ***A. nepalica***
5 Aedeagal shaft with minute corrugation on ventral side ..... ***A. shashidhari***
– Aedeagal shaft without minute corrugation on ventral side **6**
6 Apices of aedeagal processes twisted ..... ***A. spiralis* sp. nov.**
– Apices of aedeagal processes straight **7**
7 Aedeagal stem straight, close to basal appendages ..... ***A. burmensis***
– Aedeagal stem curved, well separated from to basal appendages ..... ***A. colorata***
8 Aedeagus with one pair of apical processes **9**
– Aedeagus with two pairs of apical processes ..... ***A. cruciata* sp. nov.**
9 Apex of aedeagal stem not curved **10**
– Apex of aedeagal stem curved **11**
10 Apices of aedeagal processes long and sculptured ..... ***A. rosacea* sp. nov.**
– Apices of aedeagal processes short and not sculptured ..... ***A. spinosa***
11 Aedeagal apical processes unbranched **12**
– Aedeagal apical processes branched ..... ***A. auricula* sp. nov.**
12 Aedeagal apical processes broadly curved ..... ***A. blada***
– Aedeagal apical processes narrowly curved ..... ***A. curvata* sp. nov.**

***Anaka auricula* sp. nov.**
https://zoobank.org/FFD18D4F-C13E-4AA9-9327-72711E53EE19
Fig. 1A–L

Type material. ***Holotype***, 1♂, China: Guizhou Province, Daozhen. 28.1892°N, 107.4294°E, H, 1700 m, 14.V.2006, collected by Yang Zaihua.

Description. ***Length*:** male 4.2 mm. ***Body*** (Fig. 1A, B) sandy beige. ***Crown*** (Fig. 1C) with two black patches. ***Face*** (Fig. 1D, E) yellowish, frontoclypeal area protuberant, anteclypeus broad. Pronotum yellowish brown, wider than crown. Scutellum yellowish with two blackish patches at lateral corner. ***Forewing*** (Fig. 1F) infuscate 3rd apical cell stalked, hind wing (Fig. 1G) transparent.

Male abdomen (Fig. 1H) well developed and reaching 4th abdominal sternite. ***Pygofer side*** (Fig. 1I) broad, single row of thin setae on central and apical parts.

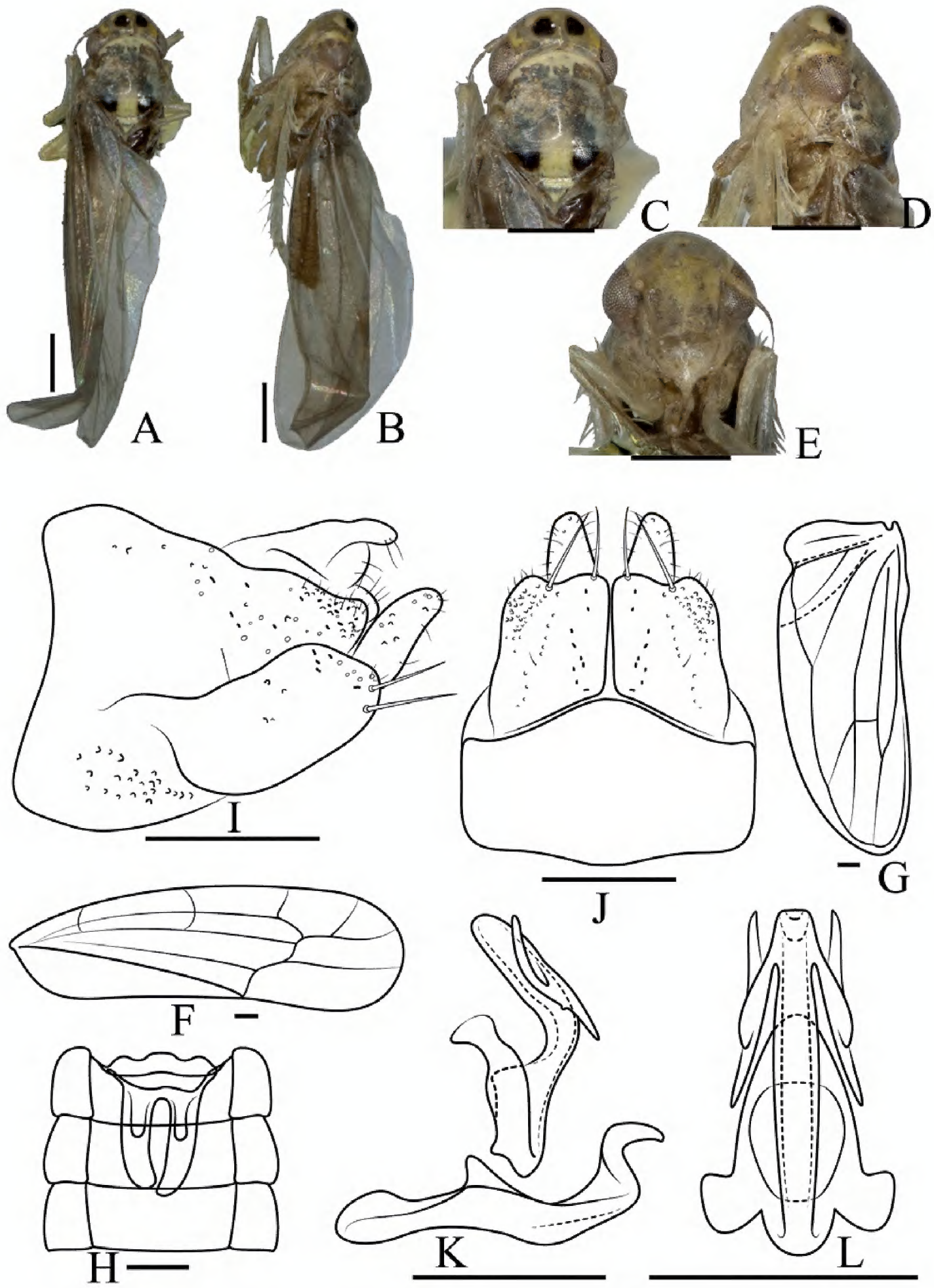

Figure 1. *Anaka auricula* sp. nov. **A** male body, dorsal view **B** male body, lateral view **C** head and thorax, dorsal view **D** head and thorax, lateral view **E** face **F** forewing **G** hindwing **H** abdominal apodeme **I** male pygofer, lateral view **J** subgenital plate, ventral view **K** aedeagus, connective, and paramere, lateral view **L** aedeagus and connective, ventral view. Scale bars: 0.5 mm (**A–E**); 0.1 mm (**F–L**).

Basal 1/2 of subgenital plate (Fig. 1J) broad, distal 1/2 slender in lateral view, two large macrosetae at approximately mid-length, several small setae near macrosetae, and scattered setae on distal 1/2. ***Paramere*** (Fig. 1K) hooked at apex. ***Aedeagus*** (Fig. 1K, L) tubular in lateral view, stem curved at middle, apical processes auricle-shaped with small spine at middle. Gonopore apical.

Etymology. The specific epithet is derived from the Latin word *auricula* (an ear) referring to the shape of the aedeagal processes.

Remarks. This species has an aedeagus very similar in form to that of *A. blada*, but it differs from that species in having elongated apical processes.

***Anaka cruciata* sp. nov.**

https://zoobank.org/71769A36-C830-407C-8082-E4575284A965

Fig. 2A–M

Type material. ***Holotype***, 1♂, CHINA: Yunnan Province, Pingbian. 22.9101°N, 103.7008°E, H, 2084 m, 22.V.2015, collected by Yan Bin.

Description. ***Length*:** male 4.2 mm. ***Body*** (Fig. 2A, B) yellowish. ***Crown*** (Fig. 2C) obtuse. Coronal suture distinct. ***Face*** (Fig. 2D–F) white, frontoclypeal area protuberant, anteclypeus broad. Pronotum yellowish, wider than crown. Scutellum small. ***Wings*** (Fig. 2G, H) without patches.

Male abdomen (Fig. 2I) reaching 4th abdominal sternite. ***Pygofer side*** (Fig. 2J) broad, with a small extension and thin setae on central and apical parts. Basal 1/2 of subgenital plate (Fig. 2K) broad, distal 1/2 slender in lateral view, one large macroseta at approximately midlength, several small setae near macrosetae, and scattered setae on distal 1/2. ***Paramere*** (Fig. 2L, M) hooked at apex.

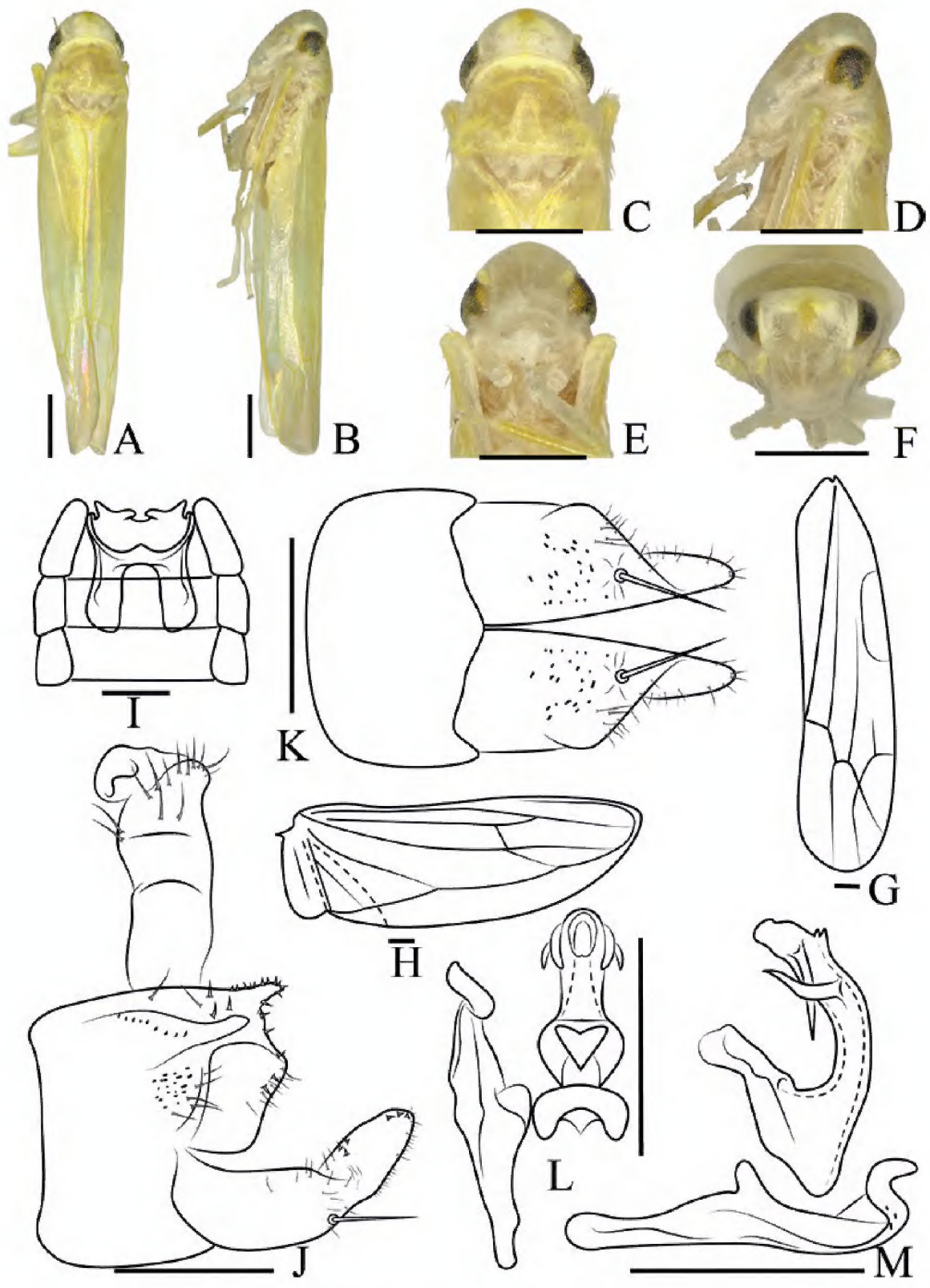

Figure 2. *Anaka cruciata* sp. nov. **A** male body, dorsal view **B** male body, lateral view **C** head and thorax, dorsal view **D** head and thorax, lateral view **E** face **F** head, frontal view **G** forewing **H** hindwing **I** abdominal apodeme **J** male pygofer, lateral view **K** subgenital plate, ventral view **L** aedeagus, connective, and paramere, dorsal view **M** aedeagus, connective, and paramere, lateral view. Scale bars: 0.5 mm (**A–F**); 0.1 mm (**G–M**).

Connective fused with aedeagus. ***Aedeagus*** (Fig. 2L, M) tubular, curved, with two pairs of apical processes, of which each pair are crossed. Gonopore apical.

Etymology. The specific epithet is derived from the Latin word *cruciatus* (marked by a cross) referring to the shape formed by the two pairs of aedeagal processes.

Remarks. This species with two pairs of aedeagal processes differs from all other species of *Anaka*, and two pairs of processes originate from subapical of stem, but in different positions.

***Anaka curvata* sp. nov.**

https://zoobank.org/2B819388-B5DB-4879-948A-162E2242B86B

Fig. 3A–L

Type material. ***Holotype***, 1♂, CHINA: Guangdong Province, Nanling National Natural Reserve, 24.8796°N, 113.0137°E, H, 1340 m. 4.VIII.2006, collected by

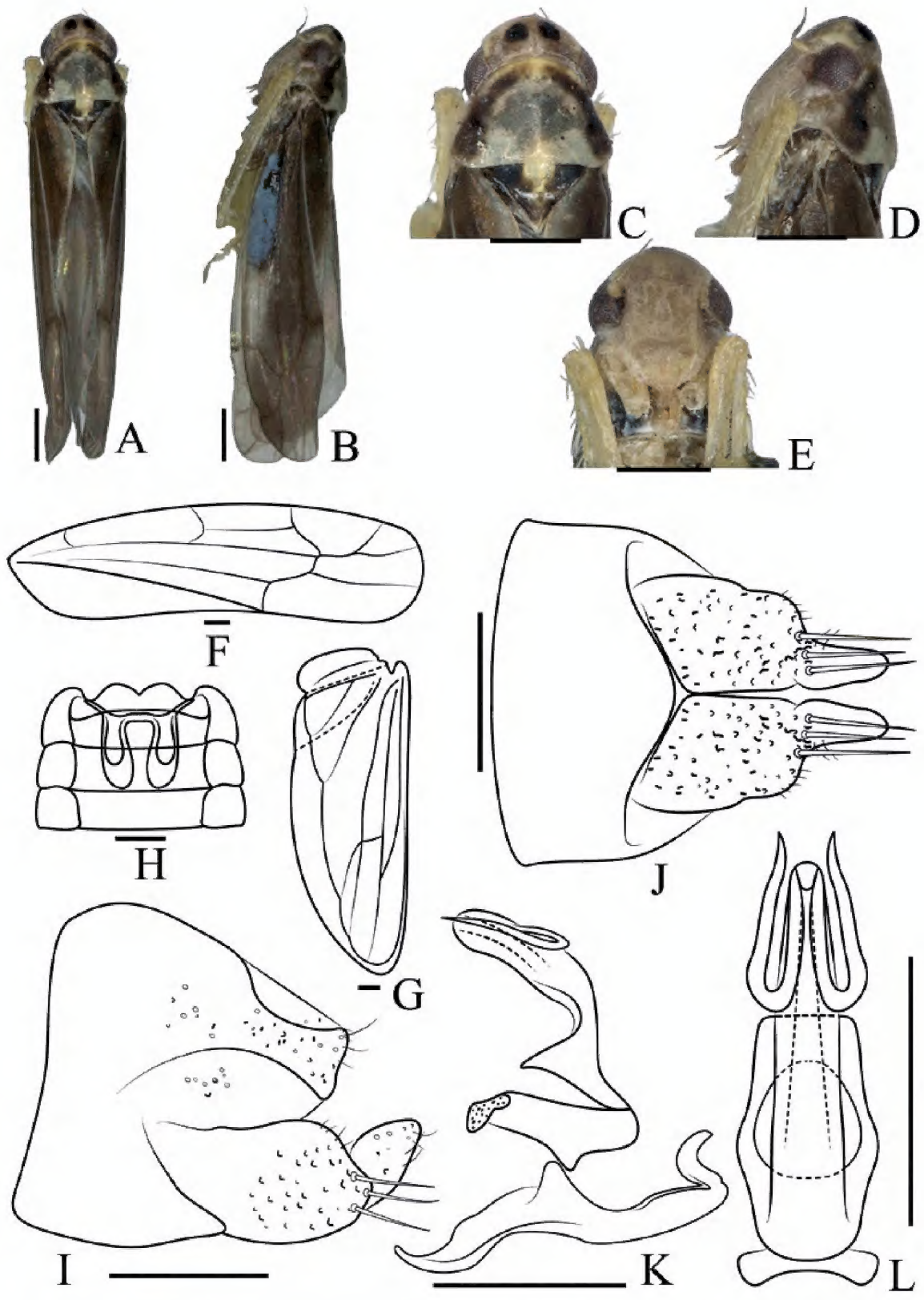

Figure 3. *Anaka curvata* sp. nov. **A** male body, dorsal view **B** male body, lateral view **C** head and thorax, dorsal view **D** head and thorax, lateral view **E** face **F** forewing **G** hindwing **H** abdominal apodeme **I** male pygofer, lateral view **J** subgenital plate, ventral view **K** aedeagus, connective, and paramere, lateral view **L** aedeagus, connective, ventral view. Scale bars 0.5 mm (**A–E**); 0.1 mm (**F–L**).

Zhou Zhonghui. ***Paratypes***, 4♂♂, China: Guangxi Province, Damingshan National Natural Reserve, 23.5049°N, 108.4153°E, H, 1290 m. 15.IV.2012, collected by Long Jiankun; 6♂♂, China: Guangxi Province, Damingshan National Natural Reserve, 23.4898°N, 108.4411°E, H, 1250 m. 14.V.2012, collected by Huang Rong and Yu Xiaofei.

Description. ***Length*:** male 4.4–4.5 mm. ***Body*** (Fig. 3A, B) brown. ***Crown*** (Fig. 3C) with two black patches. Coronal suture distinct. ***Face*** (Fig. 3D, E) yellowish brown, frontoclypeal area protuberant, anteclypeus broad. Pronotum brown, wider than crown. Scutellum with a vertical yellow stripe in the median. ***Forewing*** (Fig. 3F) infuscate, 3rd apical cell stalked, hind wing transparent (Fig. 3G).

Male abdomen (Fig. 3H) reaching 4th abdominal sternite. ***Pygofer side*** (Fig. 3I) broad, thin setae on central and apical parts. Basal 1/2 of subgenital plate (Fig. 3G) broad, distal 1/2 slender in lateral view, three large macrosetae at approximately mid-length, several small setae near macrosetae, and scattered setae on distal 1/2. ***Paramere*** (Fig. 3K) hooked at apex. Connective fused with aedeagus. ***Aedeagus*** (Fig. 3K, L) tubular, curved, with a pair of apical processes, which are curved like a paper clip. Gonopore apical.

Etymology. The specific epithet is derived from the Latin word *curvatus* (curved) referring to the shape of the aedeagal processes.

Remarks. This species is similar to *A. blada*, but it differs in having the aedeagus processes more strongly curved and less divergent from the stem.

Anaka rosacea sp. nov.

https://zoobank.org/43F14E58-F199-4013-86FB-2ED54327CB64

Fig. 4A–M

Type material. ***Holotype***, 1♂, China: Guizhou Province, Jinsha, 27.4553°N, 106.2667°E, H, 1300 m, 5.VIII.2015, collected by Zhang Yaowen. ***Paratypes***, 3♂9♀, same data as holotype.

Description. ***Length*:** male 4.4–4.5 mm. ***Body*** (Fig. 4A, B) white with red patches. ***Crown*** (Fig. 4C) obtuse, yellowish white. Coronal suture distinct. ***Face*** (Fig. 4D, E) red, frontoclypeal area protuberant, anteclypeus broad, yellowish. Pronotum yellowish, with red patches in the central part, wider than crown. Scutellum yellowish. ***Forewing*** (Fig. 4F) white with red patches along inside margin, hind wing transparent (Fig. 4G).

Male abdomen (Fig. 4H) weakly developed and reaching 4th abdominal sternite. ***Pygofer side*** (Fig. 4I) broad, apical part elliptical. Basal 1/2 of subgenital plate (Fig. 4J) broad, distal 1/2 slender in lateral view, one large macroseta at approximately midlength. ***Paramere*** (Fig. 4K) hooked at apex. Connective fused with aedeagus. ***Aedeagus*** (Fig. 4L, M) tubular, stem inflated at apex, with one pair of apical processes, apical processes straight and sculptured, oriented basad. Gonopore apical.

Etymology. The specific epithet is derived from the Latin word *rosaceus* (rose-colored) referring to the color of the head.

Remarks. This species marked with rose-red spots. The aedeagal processes are similar to *A. blada* and *A. spinosa* but differs in having the aedeagus with two long apical processes and the processes straight with spiral pattern.

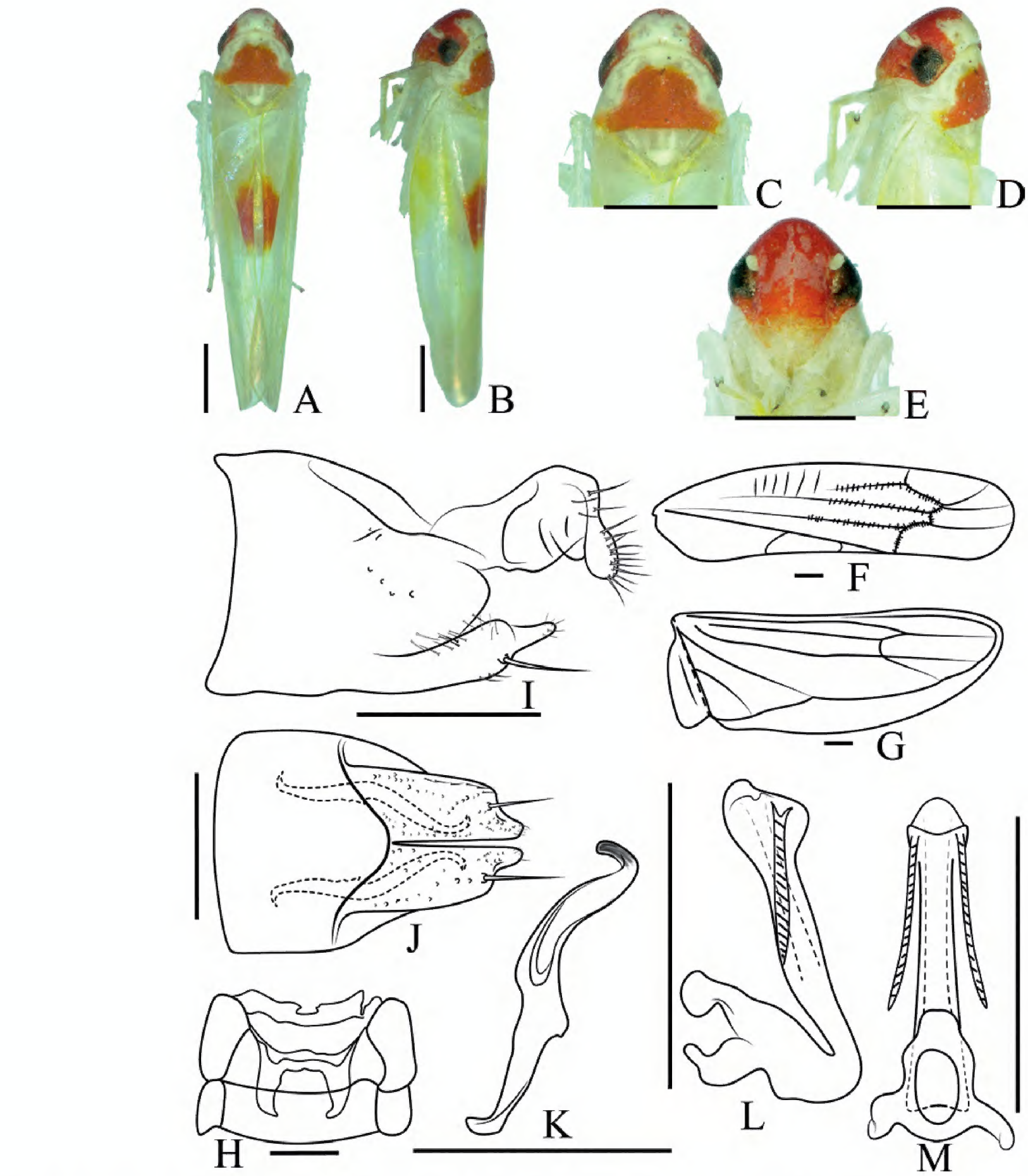

Figure 4. *Anaka rosacea* sp. nov. **A** male body, dorsal view **B** male body, lateral view **C** head and thorax, dorsal view **D** head and thorax, lateral view **E** face **F** forewing **G** hindwing **H** abdominal apodeme **I** male pygofer, lateral view **J** subgenital plate, ventral view **K** paramere, lateral view **L** aedeagus and connective, lateral view **M** aedeagus and connective, dorsal view. Scale bars 0.5 mm (**A–E**); 0.1 mm (**F–M**).

***Anaka spiralis* sp. nov.**

https://zoobank.org/FAB85DAA-EBFE-4621-ADED-BBB32FFD5514

Fig. 5A–N

Type material. ***Holotype***, 1♂, China: Yunnan Province, Baoshan, 25.1581°N, 99.0814°E, H, 1500 m, 14.V.2016, collected by Li Bin and Ren Guoru. ***Paratypes***, 3♂4♀, same data as holotype.

Description. ***Length*:** male 4.4–4.5 mm. ***Body*** (Fig. 5A, B) yellow. ***Crown*** (Fig. 5C) obtuse. Coronal suture distinct. ***Face*** (Fig. 5D–F) white, frontoclypeal area protuberant, anteclypeus broad. Pronotum yellow, wider than crown. ***Forewing*** (Fig. 5G) yellow with apical part white, hind wing (Fig. 5H) transparent.

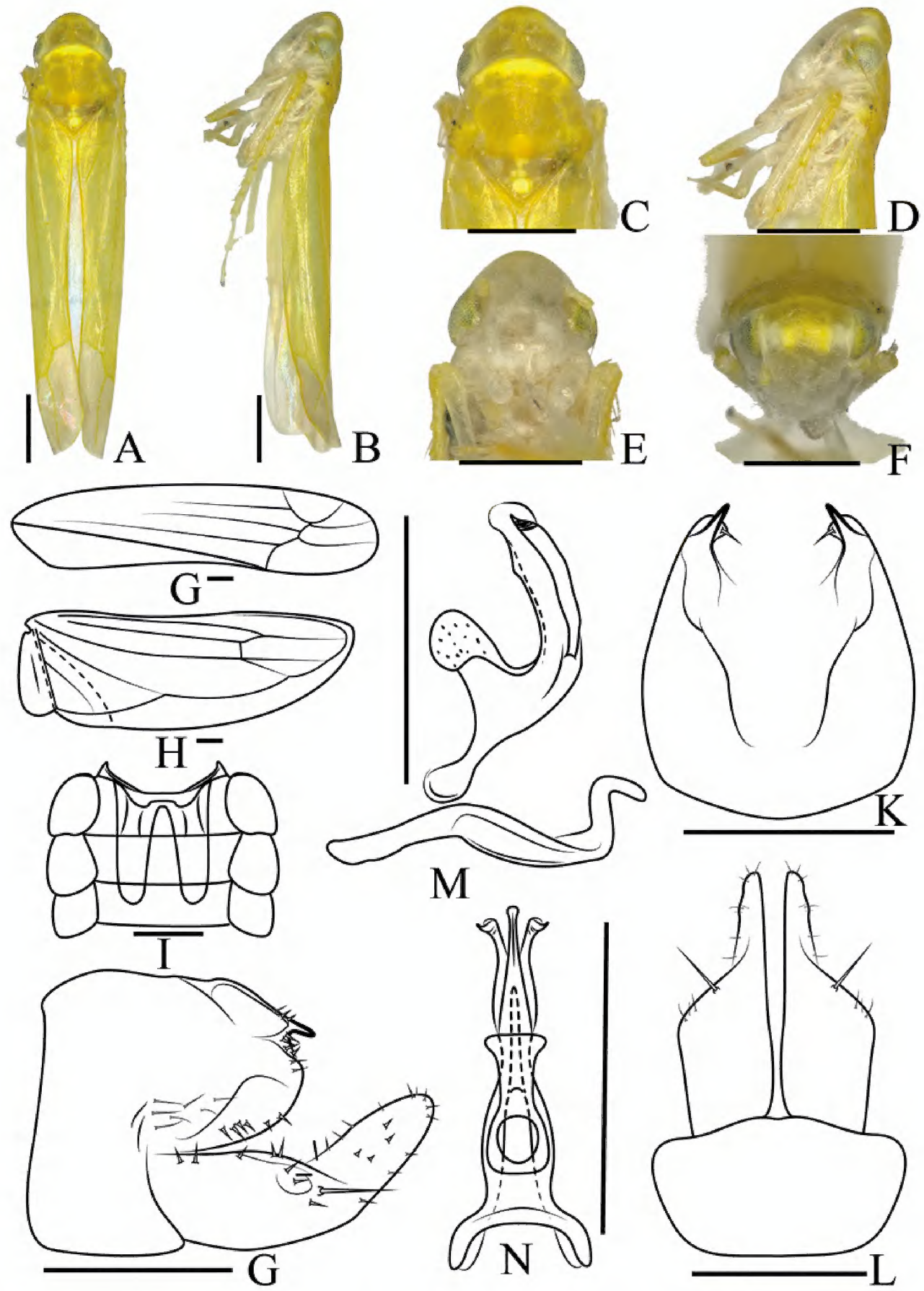

Figure 5. *Anaka spiralis* sp. nov. **A** male body, dorsal view **B** male body, lateral view **C** head and thorax, dorsal view **D** head and thorax, lateral view **E** face **F** head, frontal view **G** forewing **H** hindwing **I** abdominal apodeme **J** male pygofer, lateral view **K** male pygofer lobe, dorsal view **L** subgenital plate, ventral view **M** aedeagus, connective and paramere, lateral view **N** aedeagus and connective, dorsal view. Scale bars 0.5 mm (**A–F**); 0.1 mm (**G–N**).

Male abdomen (Fig. 5I) well developed and reaching 5th abdominal sternite. ***Pygofer side*** (Fig. 5J, K) broad, with small extension on superior margin, setae along periphery. Basal 1/2 of subgenital plate (Fig. 5L) broad, distal 1/2 slender in lateral view, one large macroseta at approximately mid-length. ***Paramere*** (Fig. 5M) hooked at apex. Connective fused with aedeagus. ***Aedeagus*** (Fig. 5M, N) tubular, with one pair of basal processes, apical part of processes spiral and not exceeding the stem. Gonopore apical.

Etymology. The specific epithet is derived from the Latin word *spiralis* (spiraling) referring to the shape of the aedeagal processes.

Remarks. In this species the aedeagus has a pair of basal processes like *A. burmensis* and *A. shashidhari*, but these basal processes have spiral-shaped top, and do not exceed the stem. These features are also not as long as in *A. nepalica*.

Acknowledgements

We are grateful to researchers in Institute of Entomology of Guizhou University for their great help in providing materials.

Additional information

Conflict of interest

The authors have declared that no competing interests exist.

Ethical statement

No ethical statement was reported.

Funding

This research was supported by the National Natural Science Foundation of China (32360393, 31802002), and the Guizhou Province Science and Technology Innovation Talent Team Project (Qian Ke He Pingtai Rencai–CXTD [2021]004).

Author contributions

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Data availability

All of the data that support the findings of this study are available in the main text.

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